

SOME SUBLITTORAL ASCIDIANS IN MORETON BAY,
AND THEIR SEASONAL OCCURRENCE

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ABSTRACT

Populations of 25 species from a limited area south of Peel Island are reported on. Five new species of the family Molgulidae are described. An unusually large number of small free living species is present, especially in the families Agnesiidae and Molgulidae, characterised by spiral branchial stigmata. Seasonal variations have been assessed from collections made at 3 monthly intervals (from March 1970 to September 1971). Most species disappear from the area in March and, for all except 2 species which are present throughout the year, enlistment in succeeding months is apparently from areas beyond the location surveyed. It is suggested that the climatic conditions, which appear to effect an annual mortality, favour small, rapidly maturing species which are able to contribute juveniles to the populations during their seasonal occurrence.

The ascidian fauna of a small area to the south of Peel Island in the southern part of Moreton Bay, Queensland, is reported on.

The collections were made in connection with a survey of the benthic fauna of the Bay being conducted by Professor W. Stephenson of the Department of Zoology in the University of Queensland; and the material was obtained from Van Veen grab samples sieved through 1.0 mm wire mesh screens. Information on the stations investigated is given on p. 253.

SPECIES LIST

APLOUSOBRANCHIA

CLAVELINIDAE

HOLOZOINAE

Sycozoa pedunculata

PHLEBOBRANCHIA

ASCIDIIDAE

Ascidia aclara

Ascidia sydneyensis

AGNESIIDAE

Agnesia glaciata

Adagnesia opaca

STOLIDOBRANCHIA

STYELIDAE

BOTRYLLINAE

Botrylloides nigrum

STYELINAE

Cnemidocarpa floccosa

Styela plicata

Styela stolonifera

Styela ramificata

Polycarpa tinctor

Polycarpa fungiformis

Polycarpa pedunculata

PYURIDAE

Pyura vittata

Microcosmus spinifera

Microcosmus exasperatus

Microcosmus australis

Microcosmus stolonifera

Microcosmus nichollsi

MOLGULIDAE

Molgula sabulosa

Molgula exigua

Molgula rima

Molgula sphaera

Molgula diversa

Eugyra moretonensis

In addition to the species in the present collections, the following have been recorded from Moreton Bay:

- Podoclavella australis* (new record: west of Myora off Dunwich, 153°4'28"E., 27°14'30"S., muddy grit, 24 ft, 18.vii.67, with larvae in brood pouch)
Eudistoma elongata; Kott, 1957
Ritterella dispar; Kott, 1957 (< *R. proliferus*; Kott, 1969)
Perophora bermudiensis; Kott, 1964
Phallusia depressiuscula; Kott, 1964
Styela orbicularis; Kott, 1964
Polycarpa longiformis; Kott, 1966
Polycarpa attollens; Kott, 1952
Polycarpa pedata; Kott, 1964
Polyandrocarpa latericius; Kott, 1964
Pyura pachydermatina; Kott, 1964
Herdmania momus; Kott, 1952, 1964

These species have been taken intertidally and by dredge from different parts of the Bay. They are, however, all fixed species. The intertidal aplousobranch fauna of Moreton Bay has not yet been properly sampled.

SYSTEMATIC DISCUSSION

A formal listing of material examined is given only in the case of new species; for other species this information can be derived from Table 1. Specimens have been lodged in the Queensland Museum (QM) collections.

Sycozoa pedunculata (Quoy and Gaimard)

- Aplidium pedunculatum* Quoy and Gaimard, 1834, p. 626.
 [non] *Aplidium pedunculatum* Cunningham, 1871, p. 490 (< *S. sigillinoides* Lesson).
 [non] *Colella pedunculata* Herdman, 1886, p. 74. Pfeffer, 1889, p. 4 (40); 1890, p. 499. Sluiter, 1900, p. 5; 1906, p. 6.
Colella pedunculata Caullery, 1908, pp. 14, 30 (specimen from King George Sound).
Colella tenuicaulis Herdman, 1899, p. 64.
Sycozoa tenuicaulis Brewin, 1953, p. 57. Kott, 1957, p. 99; 1972b, p. 8. Millar, 1963, p. 707.
Sycozoa sigillinoides Michaelsen, 1924, p. 288 (Australian specimens); 1930, p. 505 (non *S. sigillinoides* Lesson, 1830)

RECORDS: Southwestern Australia, South Australia, Victoria, New South Wales and Queensland.

DESCRIPTION: The common cloacal canals open around the free end of the colony.

REMARKS: *Sycozoa pedunculata* has been regarded as a synonym of the Antarctic species *S. sigillinoides* (see Kott, 1969). The range of the Antarctic species, therefore, apparently extended across the south coast of Australia where it overlapped the range of the Australian *S. tenuicaulis*, having been recorded from (1) the coast of Western Australia

at Cockburn Sound (*S. sigillinoides*: Michaelsen, 1930) at King George Sound (*S. sigillinoides*; Michaelsen, 1930 and *Aplidium pedunculatum* Quoy and Gaimard, 1834); (2) the Victorian coast at Westernport (*A. pedunculatum* Quoy and Gaimard, 1834, and *S. sigillinoides*; Michaelsen, 1924); and (3) the eastern Tasmanian coast and Bass Strait (*S. sigillinoides*; Michaelsen, 1924).

The antarctic species *S. sigillinoides* is distinguished from the Australian *S. tenuicaulis* by the presence of a terminal cloacal chamber with a single cloacal opening, as opposed to the ring of slit-like common cloacal openings around the free end of the head in the Australian species. The larvae of both species have an otolith but no ocellus and have the usual three triradiate papillae and adhesive suckers anteriorly. *S. sigillinoides*, however, has a larval form with a long slender tail at least one and a half times as long as the circumference of the larval body (Kott, 1969), while in *S. tenuicaulis* the tail is wider and extends only three-quarters of the way around the larva (Brewin, 1953).

A review of the descriptions of Australian specimens previously regarded as synonyms of the antarctic species has shown that they are in fact identical with Herdman's species *S. tenuicaulis*. Caullery (1908) compared the holotype of *Aplidium pedunculatum* Quoy and Gaimard, 1834, from King George Sound with specimens from the Cape Horn expedition and considered them conspecific. Caullery figured the larva of this species (fig. 7, p. 17) and although he does not identify the actual specimen from which he took his illustration it is most probable that it was the holotype of *A. pedunculatum* (in which he notes there are brood pouches containing about 12 embryos) rather than the magellanic material which he observed was not so well preserved. The larva illustrated shows the short tail typical of the Australian *Colella tenuicaulis* Herdman. There is no evidence that the specimens identified as *S. sigillinoides* by Michaelsen, from the Cockburn Sound and King George Sound in Western Australia (Michaelsen, 1930) and also those from Victoria and from Tasmania (Michaelsen, 1924) are not similarly identical. Herdman's species is therefore undoubtedly identical with *S. pedunculata* (Quoy and Gaimard).

Sycozoa sigillinoides; Brewin, 1952, and Michaelsen, 1924, both from New Zealand and *Sycozoa umbellata* Michaelsen, 1898, and *S. sigillinoides typica* Michaelsen, 1907, from the magellanic region all have the same colony form. The systems are similar to those of *S. pedunculata* with slit-like common cloacal openings around the anterior end of the head covered by a 'scale-like' flap of test (see Michaelsen, 1924). These species have an 'umbellate' colony form and probably should be assigned to the species *Sycozoa umbellata* Michaelsen recorded from New Zealand and from the magellanic region.

Sycozoa umbellata cf. *kophameli* Michaelsen, 1907, from the magellanic region has the single terminal common cloacal opening and undoubtedly should be referred to *S. sigillinoides*. The specimens described by Herdman (1886), from Kerguelen and Heard Islands and from the magellanic region all appear to be identical and have the long-tailed larva of this antarctic and magellanic species.

S. pedunculata occurs at depths of less than 300 metres on the continental shelf, while *S. sigillinoides* occurs at greater depths.

SEASONAL VARIATION: Several small typical specimens, with rooted stalks and inverted conical heads, were taken from Areas II and III in September 1971 only.

Ascidia aclara Kott

(Figs. 1-4)

Ascidia aclara Kott, 1952, p. 309; 1972b, p. 27 and synonymy.

[?] *Styelopsis scaevola* Sluiter, 1904, p. 89.

RECORDS: St Vincent Gulf; Lakes Entrance; Port Phillip Bay; Moreton Bay (end of deep water trough approaching Brisbane River mouth where not much tidal or other current flow, coll. Stephenson et al, specimens 6 to 7 cm long; 13.xii.62, 12 m, west of Hope Banks; 13.xii.62, 2 m, $\frac{1}{2}$ mile E. of middle of St Helena I., S. beacon on north of Green I.; sand and mud with shell, 8 m, $1\frac{1}{2}$ miles east of S. beacon on St Helena I., not much tide run).

? Ceram Sea, 32 m, sand and small stones (*S. scaevola* Sluiter, 1904).

DESCRIPTION: Most of the specimens in this collection are smaller than those previously available and their dorso-ventral dimension is often greater than their length. The branchial and atrial tubes are of the usual form and slightly to the left of the mid-dorsal line. The atrial tube is up to 4 times the length of the branchial tube. In several specimens there is a small gastropod in the base of the atrial tube.

The body musculature is distinctive with 3 short wide parallel bands of muscle fibres extending dorso-ventrally in the middle of the right side of the body. The corresponding bands on the left are shorter, do not extend over the visceral mass, and extend across the mid-dorsal line with the exception of the middle band which terminates at the base of the atrial aperture. The dorsal ganglion is mid-dorsal and is covered by the anterior extent of the dorsal lamina and by the branchial fold where it is drawn across onto the prepharyngeal area to the right of the mid-line. The dorsal tubercle has an S-shaped opening and, with the neural gland, is displaced to the right to open just posterior to the point where the apex of the branchial fold is attached to the prepharyngeal area. The dorsal lamina is plain-edged, and ribbed on the left side. It is located at the base of the branchial fold on its right side, and terminates at the prepharyngeal band in the mid-line. The branchial fold is formed by the anterior distortion of the left wall of the branchial sac as the dorsal section of its origin from the left side of the prepharyngeal area doubles back into a loop across the mid line onto the right side of the body. The edge of the branchial fold is, therefore, to the right of the dorsal line anteriorly, but gradually crosses the mid-line and is on the left for the greater part of its length, projecting into the left side of the pharyngeal cavity and its outer concavity accommodates the thickened body wall and the gut. The fold is associated with considerable dorso-ventral shortening of the left side of the body. The endostyle therefore appears to be half way up the left side of the body, the visceral mass is confined to the region dorsal to the endostyle, while the ventral border of the body is actually occupied by a longitudinal axis well to the right of the endostyle. It has already been observed that the muscles on the left side of the body are shortened. The gut extends anteriorly in a straight line from the oesophagus. The stomach is small, rounded and smooth. The intestine forms a very short narrow loop only occupying the distal one-half of its length. The equally short rectum extends anteriorly to form a secondary narrow loop. The gut and gonads all form a tight visceral mass embedded in the thickened body wall associated with the shortened left side of the body.

REMARKS: *Styelopsis scaevola* Sluiter is suggested as a synonym of this species since the body musculature and the arrangements of internal longitudinal vessels in the branchial sac are identical with those of the present species. Sluiter did not describe the characteristic test tubes nor the anterior origin of the branchial fold and there is some difficulty in interpreting his account of the gut and gonads. The synonymy, therefore, is not confirmed.

The morphological modifications in this species of *Ascidia* are quite unique and the stiff brittle test is also unique for the genus, and is associated with highly specialised body musculature. The species appears to be adapted for a life on the sea floor, but unless specimens are found in the open sea its widely separated records from bays and estuaries indicate a highly specialised habitat and suggest that it is a relict species.

The function of the test tubes in providing a microenvironment outside the apertures is clear and it is of interest that these maintain the usual relationship for the apertures of bottom living forms with one another and with the substrate. Thus the atrial tube is very much higher than the branchial tube (Kott, 1969a, 1969b).

In this species the unique decrease in dorso-ventral dimension of the left side of the body has forced the right side of the body into a high arc. The body is consequently dorso-ventrally flattened and is stable when lying on the wide ventral part of the right side. The mid-dorsal line and its associated apertures are thus on the upper surface and directed upwards rather than at the side as in more typical laterally flattened phlebobranchia which lie on their left side. This adaptation is probably associated with the habitat of the species on sandy sediments, which could be mobile.

SEASONAL VARIATIONS: The species was absent in March 1970 but was taken from Area II in June. There was not any appreciable increase in numbers in September although the size of the individuals had increased. Only a single specimen was present in December 1970 and the species was absent from all stations during March 1971. A relatively high number of the species reappeared in the samples in June 1971 and ranged in size from 0.8 to 2 cm. It must be assumed that a population resettled in late March or early April 1971 and grew to at least 2 cm in two months. The relatively small number of specimens present in June 1970 suggests that some physical condition could have inhibited settlement in that year. In 1971, however, the species is present in greater density and it is possible that breeding populations are established.

Ascidia sydneyensis Stimpson

Ascidia sydneyensis Stimpson, 1855, p. 387. Kott, 1972b, p. 24 and synonymy.

RECORDS: (See Kott, 1972b).

DESCRIPTION: (See Kott, 1972b). Large (4–5 cm) lying on the left side with 'tag-like' excrescences from a glassy transparent test.

SEASONAL VARIATIONS: Only occasional specimens have been taken from the Peel Island Stations during September and December. It is possible that the species settled in the area between June and September and grew to 4 cm in that time; however, in view of its sparse distribution it may be present throughout the year and have a slower growth rate.

Agnesia glaciata Michaelsen

Agnesia glaciata Michaelsen, 1898, p. 370. Kott, 1969a, p. 450 and synonymy. Monniot, 1970, p. 341.

RECORDS: From the Antarctic Peninsular, South Shetland Islands, the Patagonian Shelf and Kerguelen; California, South Africa, Japan and New Zealand.

DESCRIPTION: (See Kott, 1969a). The specimens are small, laterally flattened and sand-covered. They lie on the left side and the sandy thickened test along the right side of the apertures often overlies the less conspicuous lip on the left.

SEASONAL VARIATIONS: Specimens ranging from 0.05 to 1.5 cm were present in September 1970 and 1971, but in December only a single specimen of 1.0 cm was present. Individuals of 0.8 cm had eggs and sperm in the gonoducts in September in both 1970 and 1971. The species therefore apparently settled sometime between March and September 1970 and rapidly reached sexual maturity. In September 1971 the species was especially common in Area III.

Adagnesia opaca Kott

Adagnesia opaca Kott, 1963, p. 76; 1969a, p. 454.

RECORDS: Port Hacking (New South Wales), Moreton Bay.

DESCRIPTION: (See Kott, 1963, 1969a). Specimens up to 6 cm in greatest diameter are available. There is some variation in the extent to which the folds of test protecting the apertures are produced into flap-like lips and these are not apparent in very small specimens where the branchial aperture is terminal and the atrial aperture antero-dorsal. Lips cover the atrial aperture from below and the branchial aperture from above. The species is sometimes found with specimens of *Molgula sabulosa*.

SEASONAL VARIATIONS: As with *Ascidia sydneyensis* the species was absent in March and June 1970. In September 1970 individuals from 1.5 to 6.0 cm were taken and a single specimen of 5 cm was taken in December 1970. The species was absent in March 1971. In June 1971 specimens from 2.0 to 3.0 cm were taken and in September 1971 specimens from 1.0 to 6.0 cm were taken. There is no great increase in the number of specimens present however and it does not appear that the resident population contributes to the juveniles which settle between June and September. The species appears to grow at a minimum rate of 3 cm in a 3 month period.

Botrylloides nigrum Herdman

Botrylloides nigrum Herdman, 1886, p. 50. Kott, 1972b, p. 30 and synonymy.

RECORDS: (See Kott, 1972b).

DESCRIPTION: (See Kott, 1972b).

SEASONAL VARIATIONS: A single irregularly lobed colony only was taken from Area II in September 1970. It is not likely to be a regular component of the bottom fauna since it is a fixed species and requires either weed or firm substrate to adhere to. The present specimen was probably washed into the area.

Cnemidocarpa floccosa (Sluiter)

Styela floccosa Sluiter, 1904, p. 64.

RECORDS: Kei Islands, Arafura Sea, sand and coral.

DESCRIPTION: Specimens are more or less crescent shaped with the dorsal border concave, and the ventral border longer and convex. The shape of the body is obscured by the very thick (up to 0.5 cm) coating of sand, mud and shells adhering to the long tough fibrous extensions rising from the ends of short thick protuberances all over the surface of the test. The test itself is very tough. The terminal branchial siphon is long projecting through the thick layer of sand and mud. The atrial siphon is about one-third the length of the branchial siphon and extends straight up from the posterior end of the dorsal border. The fibrous extensions of the test to which the sand and mud adhere also adhere to other specimens to form aggregates with other individuals of the same or different species.

The body wall is not especially muscular. There is a slightly convoluted opening on the large dorsal tubercle at the base of an elongated peritubercular area. The dorsal lamina is narrow and plain edged. The longitudinal vessels are arranged as follows: DL 1(16) 3(16) 3(16) 3(15) 3E.

The gut forms a simple narrow loop across the posterior end of the body and encloses a long narrow flat-topped endocarp in the loop. The anal border is plain. Anterior to the gut loop there are 8 very long narrow cnemidocarp gonads extending from the antero-ventral border of the body and converging to the base of the atrial siphon. There are 14 similar gonads on the right side of the body completely occupying the inner body wall.

REMARKS: Sluiter's specimens only had 5 long narrow gonads on each side of the body. They were, however, identical with the present species in every other way. The shape of the body, position of the atrial aperture and the simple gut loop and the fibrous extensions from the test distinguished the species.

SEASONAL VARIATIONS: The species was absent in March 1970 and March 1971. In June 1970, juveniles of 0.5 and 1.0 cm were present together with a specimen of 5 cm. The individuals taken in September, December 1970 ranged from 1 to 5 cm and it is clear that juveniles were settling in the area continuously through the months from late March or early April to December. The species was again taken in June and September 1971. If the largest specimen present in June 1970 represents a relict population from the previous year that was not sampled in March, the species appears to grow at a rate of about 3 cm during a 3 month period. The number of specimens present in the population does not markedly increase at any time and reproduction does not appear to have taken place.

Styela plicata (Lesueur)

Ascidia plicata Lesueur, 1823, p. 5.

Styela plicata; Kott, 1952, p. 216 and synonymy.

RECORDS: Cape Jaubert, Shark Bay (Western Australia); Port Jackson (New South Wales); Moreton Bay, Hervey Bay (Queensland); Japan; Indonesia.

DESCRIPTION: As previously described: oval, upright with sessile apertures and a soft to leathery, white, longitudinally furrowed test. There are up to 8 internal longitudinal vessels between the branchial folds and up to 30 on the folds. The stomach is long and voluminous with longitudinal folds. The gut forms a narrow vertical primary loop. The rectum extends anteriorly to form a deep secondary loop. The anus has about 15 deep lobes. There are two styelid gonads on each side of the body. The posterior gonad on the left side extends down into the secondary gut loop.

SEASONAL VARIATIONS: This species has been known as one of the more common species in Port Jackson, Moreton Bay and other locations including the Swan River estuary in Western Australia (Kott, 1952), and appeared to tolerate greater fluctuations in salinity than many others. It is not common in the present survey, however, and was taken only in small numbers in September 1970 and June 1971. The specimens taken in September 1970 ranged from 1.5 to 2 cm and probably settled in late June; while in June 1971 specimens ranged from 0.5 to 2.5 cm, and probably settled over the period from late March to June. The species was not taken from Area I. It does not appear to be present for long enough to reach sexual maturity, nor in sufficient density for sexual reproduction.

***Styela stolonifera* Herdman**

Styela stolonifera Herdman, 1899, p. 42. Kott, 1966, p. 298 and synonymy.

RECORDS: (See Kott, 1966). Present records indicate a discontinuous distribution and the species may possibly have been overlooked at other locations.

DESCRIPTION: Characteristic appearance, with both apertures on almost parallel siphons projecting upwards from the anterior surface. The body expands into a rounded postero-dorsal swelling and is supported on a short stalk or 2 to 3 short thick roots. The test is leathery, whitish, and naked and longitudinally furrowed. The dorsal tubercle has a U-shaped slit with horns rolled in. The body wall is very thin and closely adherent to the test. There is an outer circular layer of muscles and inner longitudinal bands. There are 10 to 12 internal longitudinal vessels on deeply curved folds and 2 to 3 between. The gut loop is long, rather narrow, and only slightly curved with the proximal limb extending postero-ventral to the branchial sac. There are 4 to 5 tall almost foliaceous endocarps enclosed in the pole of the loop. Endocarps are also present all over the body wall. The large stomach is long with longitudinal folds which are apparent externally. The anal border has shallow rounded lobes. There are two long branched gonads on the left and 3 on the right.

REMARKS: The rounded swollen postero-dorsal aspect of the body is similar to the condition found in *Styela pedata*, although the species are distinguished by the form of the opening of the dorsal tubercle. It is also closely related to *Styela ramificata* but is distinguished by the well spaced internal longitudinal vessels on the deeply curved folds which accommodate to the greatly shortened dorsal border, the closely placed apertures on the upper surface and the considerable lengthening of the dorso-ventral axis of the body. The long narrow simple gut loop also accommodates to this lengthening of the body and differs from that of *S. ramificata* which forms a shorter loop and in which the rectum

extends anteriorly to form a secondary loop. Externally the stomach folds of *S. ramificata* are obscured by the typhlosolar fold and a thickened membrane covering the gut.

SEASONAL VARIATIONS: The species was absent only in June 1971. Juveniles of less than 1.0 cm were taken in June 1970 and September 1971. In 1970 specimens of maximum size (3.5 and 4.5 cm) were taken in December. Although gonads are developed when the individuals are over 2 cm, no juveniles appeared until the following September (1971). These populations, therefore, do not appear to be producing offspring which settle in the area. Although its apparent growth rate of about 1 cm per month is similar to that of other species sampled, it is one of the few that does not reach sexual maturity until it is relatively large, and it is possible that some seasonal incident terminates its present in the area before sexual reproduction can take place. Alternatively, these sparse populations, probably peripheral to more dense and reproducing populations in an adjacent area, may not reach the necessary density to effect sexual reproduction.

***Styela ramificata* Kott**

(Fig. 7)

Styela ramificata Kott, 1952, p. 214; 1972a, in press, and synonymy.

RECORDS: Moreton Bay, Townsville, Gulf of Carpentaria.

DESCRIPTION: The specimens are large and sandy with the apertures close together on the upper surface. The test is covered with stout projections with long terminal branching hairs that entangle the sand and mud. These are not present in small specimens. There is a bluish colour lining the outer parts of the siphons. The dorsal tubercle is large and prominent and has a U-shaped slit with both horns turned in. The branchial folds are low and wide basally but converge to a sharp rim. There are 30 internal longitudinal vessels crowded on the folds and 9 between. There is an almost vertical narrow gut loop enclosing 2 to 4 tall foliaceous endocarps in the pole. The oesophagus is especially long. The stomach is long with a pronounced typhlosolar fold along its mesial aspect where it projects into the lumen. The outer concavity of this fold is filled with a thickening of the membrane over the gut. There are also long glandular folds in the stomach but these are apparent only from inside the stomach. There is a very small pyloric caecum and a gastro-intestinal connective from the pyloric end of the stomach. The rectum forms a secondary gut loop and terminates in an anus with the border divided into 14 shallow rounded lobes. There are long branching gonads similar to those of *S. stolonifera* crowded on both sides of the body (see Kott, 1952), with testis follicles along both sides of the ovary.

REMARKS: The hairs on the test and the sandy coating are reminiscent of *Cnemidocarpa floccosa* but the species is distinguished by its characteristic gut with an internal typhlosolar fold, and by the form and orientation of the gonads which are more crowded than those of *Styela stolonifera*.

SEASONAL VARIATIONS: Individuals present increase in size from March to December 1970, although no juveniles have been taken after June, and the samples taken do not suggest a reproducing population. The situation appears to be similar to that demonstrated

by the *Styela stolonifera* population in this location which appears to be marginal to more densely populated centres from which enlistment takes place. The species has not been taken from Area I.

***Polycarpa tinctor* (Quoy and Gaimard)**

Ascidia tinctor Quoy and Gaimard, 1834, p. 608. Millar, 1962, p. 399. Kott, 1964, p. 134 and synonymy.

RECORDS: Northwestern and northeastern Australia, Indonesia, Japan.

DESCRIPTION: (See Kott, 1964). There are small protruberances of the test around the meridian which support hair like extensions that probably help in keeping the individual in place on the sandy bottom.

SEASONAL VARIATION: This is one of the most common species sampled and is present throughout the year. It was taken only in small numbers in March 1970. The numbers increased to a peak in September, were slightly reduced in December, and in March and June 1971 were again only rare components of the fauna sampled. Juveniles begin to settle in the area before June, and continue to settle until September. Thereafter there is some mortality of the older members of the population which begins to increase with the onset of reproduction and the addition of juveniles to the populations in June–September. Millar (1962) has observed that the species is anural and viviparous and that the incubation period within the parental peribranchial cavity is of several weeks duration. There is therefore probably little migration from adjacent areas and the populations are self-perpetuating in the area under consideration.

***Polycarpa fungiformis* Herdman**

Polycarpa fungiformis Herdman, 1899, p. 43. Kott, 1964, p. 137 and synonymy.

RECORDS: Moreton Bay, Great Barrier Reef (off Port Douglas).

DESCRIPTION: The specimens are uniformly black and fungiform, with short narrow stalk and large oval body slightly dorso-ventrally flattened with the sessile aperture close together on the upper surface. The outer surface of the test is transversely wrinkled. Juvenile specimens, up to 2.0 cm, are more or less vertical with the stalk from the posterior end of the body. In these specimens the test is less leathery, often gelatinous, semi-transparent, and in the smaller specimens is produced into long hairs to which sand and shell particles adhere. The body wall is always closely adherent to the test. The dorsal tubercle is large and completely fills the triangular peritubercular area. The tubercle, even in the smallest specimens has a porous spongy appearance caused by its many openings. The branchial folds are rounded with about 15 thick internal longitudinal vessels crowded on them but only one between the folds. The branchial sac is especially tough. The gut forms a simple rounded loop enclosing a round to comma shaped flat-topped endocarp. The rectum extends anteriorly almost parallel to the gut loop and ends in a lobed anus. The polycarps are upright and tapered at the base and at their free end.

REMARKS: Internally the species resembles *Polycarpa pedunculata* in its tough branchial sac and the gut with its enclosed endocarp. The distinctive form of the dorsal tubercle is

maintained even in very small specimens. In the smaller juvenile specimens the black colour characteristic of the species is less intense, and sometimes is present only in flecks in the test.

SEASONAL VARIATIONS: There is a population of large individuals of more than 3.0 cm present throughout the year, especially frequent in Area II, and present in greatest numbers during December 1970. Juveniles from 0.3 to 1.0 cm were taken in June 1970, and from 1.0 to 2.0 cm in September 1970. It appears therefore that spawning took place between March and June 1970 and that the juveniles grew to sizes greater than 2.0 cm by December. The numbers of adults taken were very much reduced in March 1971 when there appears to have been some mortality, possibly of older members of the population and in June 1971 juveniles are again present. The species therefore appears to be present as a reproducing population, producing a single generation each year. Although the life span of each individual is not known the population level is maintained by the addition of the developing juveniles and a corresponding annual mortality, possibly of adults over a year old.

***Polycarpa pedunculata* Heller**

Polycarpa pedunculata Heller, 1878, p. 106. Kott, 1972b, p. 35 and synonymy.

RECORDS: (See Kott, 1972b).

DESCRIPTION: The specimens from this location do not show the polymorphism described from St Vincent Gulf (Kott, 1972b). They are a pale creamish colour in preservative. The test is tough and without sand or shell adhering. The body is oval with a terminal sessile branchial aperture and a sessile atrial aperture halfway along the dorsal surface. The short stalk is produced from the postero-ventral aspect of the body. The body wall is muscular with the usual vesicular cells interrupting the fibres. The branchial sac is tough with low rounded folds. The dorsal tubercle has a U-shaped slit with both horns usually turned out. The gut encloses the usual circular endocarp.

REMARKS: The species is often similar in shape to *Polycarpa fungiformis* and the gut loop is identical and encloses a large flat-topped endocarp. The dorsal tubercle is the only character which can be used to distinguish immature specimens of these species, when neither the gonads nor the black pigmentation of *P. fungiformis* are developed.

SEASONAL VARIATIONS: The species is not a very common component of the fauna of this area. Only a single juvenile was taken in September 1970 when adults of 6 and 7 cm respectively were also present. Individuals of 2.75 and 3.5 cm were taken in December; a single individual of 2.5 cm was taken in March 1971; 4 individuals of 4.0 to 4.25 cm were taken in June 1971. It appears therefore that occasional individuals are enlisted from a breeding population outside the area from September to December, grow to about 3 cm in three months and reach their maximum size of about 7 cm within 12 months. The species does not, however, reach a sufficient density to form a breeding population in the area sampled.

***Pyura vittata* (Stimpson)**

Cynthia vittata Stimpson, 1852, p. 230.

Pyura vittata: Kott, 1972b, p. 37 and synonymy.

RECORDS: (See Kott, 1972b).

DESCRIPTION: The body is an irregular inverted pyramid with the branchial aperture on the outer rim of the upper surface surrounded by conspicuous black and white stripes. The opposite side of the upper surface conceals 3 large lamellibranch molluscs within the test. Similar black and white stripes surround the sessile atrial aperture which is half way along the upper surface. These conspicuous stripes that surround the apertures are continuous with the inner siphonal linings and are covered with the needle like spines characteristic of the species. In the single specimen taken during the course of this survey these black and white stripes interrupt the otherwise sandy surface on a strip between the atrial aperture and the area of test in which the lamellibranchs are embedded. It has probably resulted with growth and healing of the test following entry of the lamellibranchs.

SEASONAL VARIATION: Only a single large specimen was taken in March 1970. The species is very often taken from the sea floor but is not free living and on the sandy substrate available at this location there are no suitable rocks, shells etc. to provide a suitable surface for attachment.

Microcosmus spinifera (Herdman)

Cynthia spinifera Herdman, 1899, p. 32.

Microcosmus spinifera; Kott, 1952, p. 286.

RECORDS: (See Kott, 1952).

DESCRIPTION: (See Kott, 1952). Individuals have short stalks or root-like processes or are sessile on scallop shells. The surface test on the rest of the body is produced into the usual pointed spines which are especially thick and long around the apertures. There are 6 high overlapping folds on both sides of the body. The gonads are long and continuous. The left gonad crosses the descending limb of the gut loop into the pole of the gut loop.

SEASONAL VARIATIONS: Specimens were taken in June and September in 1970 and 1971. It is not a very frequent component of the fauna and there is no indication that a reproducing population is set up.

Microcosmus exasperatus Heller

(Fig. 8)

Microcosmus exasperatus Heller, 1878, p. 99.

Microcosmus claudicans sub sp. *exasperatus*; Michaelsen and Hartmeyer, 1928, p. 403 and synonymy.

RECORDS: (See Michaelsen and Hartmeyer, 1928).

DESCRIPTION: Only 2 individuals were taken, one attached to a shell by a widely spread flat base, the other rounded, posteriorly. Both apertures are fairly close together and are on short siphons directed away from one another. The test is tough, leathery and whitish and is produced into lobes around the apertures. The slit on the dorsal tubercle is U-shaped with both horns unrolled. There is a tricuspid valve formed by folds of the siphonal lining at the base of the branchial siphon. Pointed spines 0.05 mm long line the siphons. In the

juvenile specimen of 0.6 cm diameter there are 7 branchial folds but the specimen of 3 cm diameter has 9 folds on each side of the body with 1 to 2 internal longitudinal vessels between and 18 to 20 on the folds. The gut forms a deeply curved narrow loop. The gonads are subdivided into 3, the most proximal division crossing into the pole of the gut loop on the left. The liver is composed of groups of parallel lamellae.

SEASONAL VARIATIONS: Only two specimens were taken, a juvenile in June 1970 and a specimen of 3 cm in December. The species does not set up a breeding population in this location and its occurrence is clearly the result of enlistment from elsewhere in the Bay.

***Microcosmus australis* Herdman**

(Fig. 9)

Microcosmus australis Herdman, 1899, p. 23. Kott, 1972a, in press, and synonymy.

RECORDS: (See Kott, 1971).

DESCRIPTION: The test is tough, leathery, wrinkled and whitish. The dorsal tubercle is U-shaped with both horns rolled in. There are 7 branchial folds on each side of the body. The gonads and gut are of the usual form. Small pointed spines 0.02 to 0.03 cm are present lining the siphons.

REMARKS: This species resembles *M. exasperatus* in every aspect except the size of the spines lining the siphons.

SEASONAL VARIATION: Only a single specimen was taken, in December 1970. Since it was 2 cm in diameter it is probable that it settled sometime between September and December from an adjacent breeding population.

***Microcosmus stolonifera* Kott**

Microcosmus stolonifera Kott, 1952, p. 291; 1972b, p. 43 and synonymy.

RECORDS: Spencer Gulf, St Vincent Gulf, Tasmania, Westernport.

DESCRIPTION: Posteriorly the two specimens of this species that were taken are produced into roots with adhering sand. The siphons are anterior and fairly close together but the thickening of test around the siphons is not developed. There are 7 branchial folds on each side of the body. The gut loop is very narrow. The gonads are rounded and the left gonad is in the curve of the gut loop and does not extend over into the primary loop.

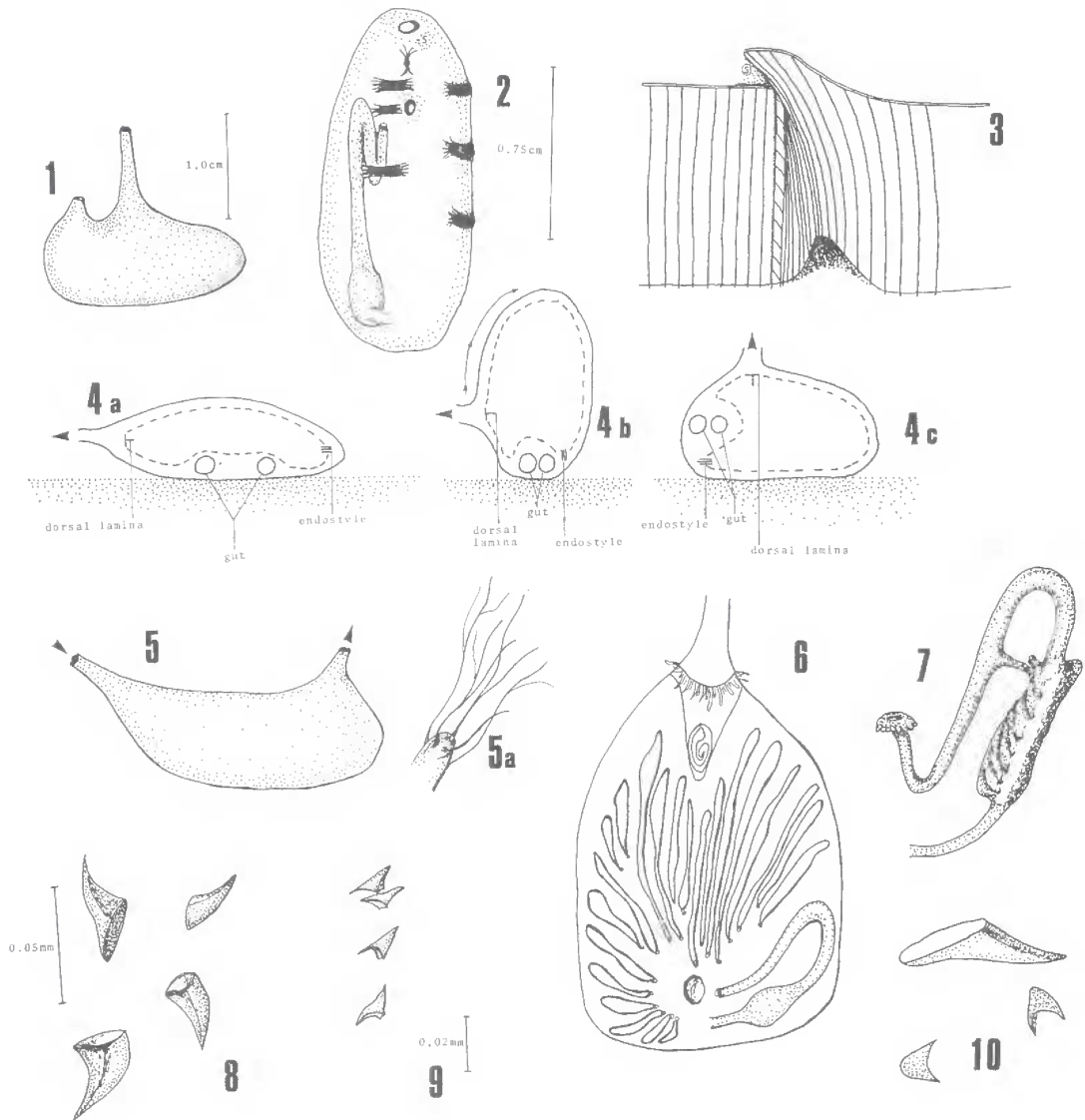
SEASONAL VARIATION: Only two specimens of 2 cm were taken in June 1970.

***Microcosmus nicholli* Kott**

(Fig. 10)

Microcosmus nicholli Kott, 1952, p. 290; 1972b, p. 42 and synonymy.

RECORDS: St Vincent Gulf, Westernport, and Victoria.



FIGS. 1-4: *Ascidia aclara*. 1, Individual. 2, Individual removed from test viewed from above showing muscle bands, gut loop and dorsal ganglion. 3, Diagram of antero-dorsal portion of the branchial sac showing the origin of the branchial fold from the prebranchial area anterior to the dorsal tubercle. 4, Diagrammatic transverse sections showing possible evolution of *A. aclara*— a, laterally flattened, free living ancestral form; b, shortening of left side of the body altering stability; c, stable dorso-ventrally flattened *A. aclara*.

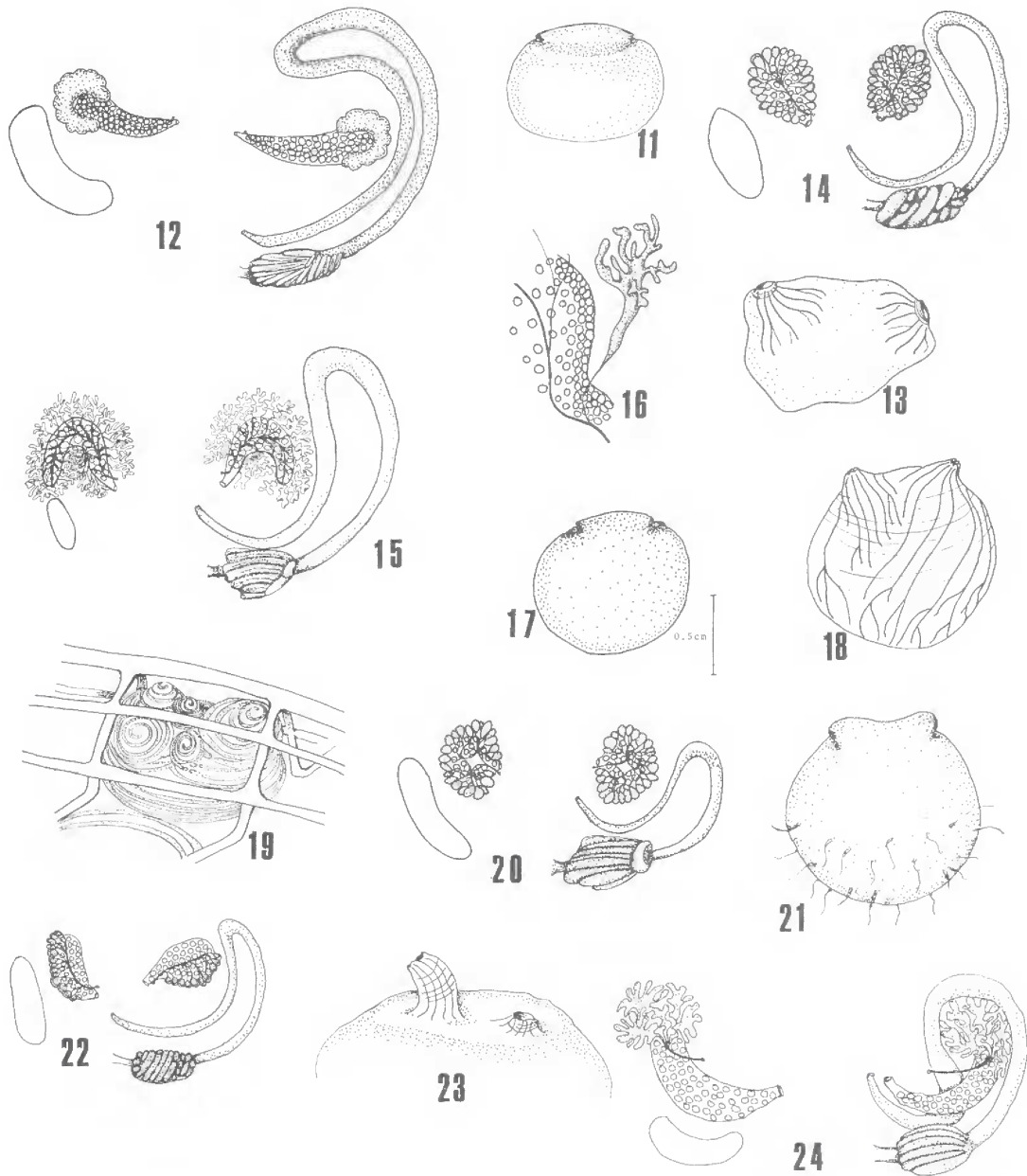
FIGS. 5, 6: *Cnemidocarpa floccosa*. 5, Individual removed from test. 5a, Test hair of *C. floccosa*. 6, Individual opened round ventral surface; branchial sac removed to show gonads and gut.

FIG. 7: *Styela ramificata*. Gut loop showing typhlosolar groove in stomach wall.

FIG. 8: *Microcosmus exasperatus*. Branchial spines.

FIG. 9: *Microcosmus australis*. Branchial spines.

FIG. 10: *Microcosmus nichollsi*. Branchial spines.



FIGS. 11, 12: *Molgula sabulosa*. 11, Whole individual. 12, Kidney, gut loop and gonads on inner body wall.
 FIGS. 13, 14: *Molgula exigua*. 13, Individual removed from test. 14, Kidney, gonads and gut loop on inner body wall.
 FIGS. 15, 16: *Molgula rima*. 15, Kidney, gonads and gut loop on inner body wall. 16, Single testis follicle and portion of the ovary and vas deferens.
 FIGS. 17–20: *Molgula sphaera*. 17, Whole individual. 18, Individual removed from test. 19, Portion of branchial sac showing sub-divided infundibulum. 20, Kidney, gonads and gut loop on inner body wall.
 FIGS. 21, 22: *Molgula diversa*. 21, Whole individual. 22, Kidney, gonads and gut loop on inner body wall.
 FIGS. 23, 24: *Eugyra moretonensis*. 23, Anterior portion of individual showing branchial and atrial apertures. 24, Kidney, gonads and gut loop on inner body wall.

DESCRIPTION: Only a single specimen was taken. It is spherical, with the apertures close together on the upper surface. In contrast to other species of *Microcosmus* taken in this survey, the test is thin and rigid with sand, rather than tough and leathery. There are 7 branchial folds on each side of the body with about 10 internal longitudinal vessels on the folds and 1 to 2 between. The left gonad extends into the pole of the gut loop but is very immature. There are small scales lining the siphons with long, pointed spines more sparsely distributed amongst these.

SEASONAL VARIATION: The single juvenile specimen was taken in September 1970.

***Molgula sabulosa* (Quoy and Gaimard)**

(Figs. 11, 12)

Ascidia sabulosa Quoy and Gaimard, 1834, p. 613. Michaelsen and Hartmeyer, 1928, p. 449 and synonymy. Kott, 1952, p. 298 (part). Millar, 1966, p. 374.

[?] *Molgula mollis* Herdman, 1899, p. 54. Kott, 1972b, p. 45 and synonymy.

RECORDS: Indonesia and circum-Australia.

DESCRIPTION: The species is common and forms large aggregates of individuals. They are laterally flattened and circular in outline. The test is usually rigid with sand. Both apertures are close together anteriorly on very short siphons directed away from one another and sometimes depressed into the upper surface. There is a ridge of test extending along between both apertures accentuating their orientation away from one another. The test around the apertures may be thickened into a rounded rim. The dorsal lamina is very short and the branchial folds are deeply curved. There are 7 branchial folds on each side of the body with 7 to 11 internal longitudinal vessels on each fold but none between. There are a large number of infundibula along each branchial fold and these subdivide on the summit of the fold. The internal longitudinal vessels and the transverse vessels tend to subdivide and anastomose at the base of the folds and in the interspace especially dorsally. The infundibula also subdivide and form interstitial coils. The gut forms a narrow curved loop and there is a narrow curved kidney on the right. The gonads consist of an elongate ovary with a semicircle of testis follicles around the proximal end. On the left the gonad extends out of the secondary gut loop toward the atrial aperture. On the right the gonad extends anterior to and at an angle to the length of the kidney, diverging toward the atrial aperture. In specimens of 0.5 cm and less the gonads are not developed.

REMARKS: The relationships between this species and *Molgula mollis* are not clear. The branchial sac differs only in the reduced number of internal longitudinal vessels (which varies with size in the present specimens); the gonads, kidney and gut are identical in the two species; and differences in external appearance could well be associated with the size of the individuals. *Molgula sabulosa* has been recorded from a wide range of localities. *Molgula mollis* has been recorded from New South Wales, Queensland and South Australia and could well represent young specimens of the present species.

SEASONAL VARIATION: The species is one of the most common components of the fauna at this location and is found in large aggregates, often with *Styela ramificata*. The species appears to occur annually. There was only a single specimen taken in March 1970

and it was completely absent from the hauls in March 1971. It was absent in June 1970 and 1971. It was present in September of both years. In December 1971 it was especially common and ranged in size from 0.5 cm to 3 cm. Thus the species apparently settles, especially in the Areas II and III, from late August or early September. Gonads appear well developed in specimens of 2 cm or more and since enlistment in December 1970 occurred at an increased rate, it is probable that maturing individuals are reproducing to contribute juveniles to the population at that time. The species is, therefore, probably present in sufficient density to reproduce sexually. The absence of the species during June 1970 and March–June 1971 may be caused by some physical factor (such as flooding). Populations thus are not self-perpetuating and initial enlistment must be from some region outside the area surveyed that is not exposed to this seasonal factor.

***Molgula exigua* sp. nov.**

(Figs. 13, 14)

HOLOTYPE: $\frac{1}{2}$ mile S. of Southwest Rocks, Moreton B., sand shell and grit, 7.7 m, June 1971, QM G6322.

PARATYPES: $\frac{1}{2}$ mile SE. of Southwest Rocks, Moreton B., mud, 5 m, 1 spem., QM G6020. $\frac{1}{2}$ mile S. of Southwest Rocks, Moreton B., sand shell and grit, 7–10 m, 29 spems., QM G5999, G6007–19, G6021–2, G6323. 1 mile S. of Southwest Rocks, Moreton B., sandy mud, 2.5–6 m, 32 spems., QM G5990, G5993–8, G6000–6.

DESCRIPTION: Individuals are small and rounded and relatively firm. There are sand particles adhering over the whole of the body attached to the test and to hair-like extensions of the test. These are larger around the siphons. The apertures are sessile and far apart, almost at opposite ends of the body. There is a broad velum in the base of both very short siphons with only a small aperture in the centre of each. The dorsal lamina is long, about three-quarters of the maximum length of the branchial sac. There are 6 rows of 6 coiled infundibula, each projecting only slightly, with 1 to 3 internal longitudinal vessels close together along the centre of each row above the apices of the infundibula. There is a seventh row of infundibula dorsally, on each side of the dorsal lamina, that is not crossed by internal longitudinal vessels. There are some interstitial stigmatal coils. The infundibula subdivide into 2 in the most ventral row.

The gut forms a narrow curved loop and the kidney is short and oval and not curved. The gonads consist of a short flask-shaped ovary with the short oviduct directed toward the atrial aperture, and completely surrounded by testis follicles which sometimes encroach onto the mesial surface of the ovary. The vasa efferentia join on the mesial surface of the ovary and form a median vas deferens opening at the base of the oviduct. The right gonad is dorsal to and almost parallel to the kidney directed posteriorly to the atrial aperture; the left gonad extends from just inside the pole of the gut loop toward the atrial aperture.

REMARKS: The rather stiff test with slightly larger sand grains adhering, the widely separated apertures, the almost flat undivided infundibula, the large siphonal vela, and the shape and orientation of the gonads are all characteristic of this species.

SEASONAL VARIATIONS: The species was taken in sizes ranging from 0.3 to 1.0 cm in all months except March 1970 and 1971. There appears to be some mortality of larger

specimens from December although smaller specimens are still present. Gonads are mature in individuals of 0.5 cm and these probably contribute juveniles to the population. The larger adults appear to die off from December, and although some smaller individuals persist these had also disappeared in March. Therefore, it appears that individuals of this species have a life span of less than 12 months, and that for the greater part of this period they are reproducing. Resettlement in the succeeding year is probably from a persisting population in an adjacent area.

***Molgula rima* sp. nov.**

(Figs. 15, 16)

HOLOTYPE: $\frac{1}{2}$ mile S. of Southwest Rocks, Moreton B., sand shell and grit, 7.7 m, June 1971, QM G6324.

PARATYPES: $\frac{1}{2}$ mile S. of Southwest Rocks, Moreton B., sand shell and grit, 7–10 m, 21 spems., QM G6023–8, G6030–6, G6325–7. 1 mile S. of Southwest Rocks, Moreton B., sandy mud, 3.5–6 m, 27 spems., QM G6037–44.

DESCRIPTION: Each individual is small and oval, laterally flattened and covered with a very thick coating of fine sand and mud that is held in place by very long hair-like processes from the surface of the very thin transparent test. The coating of sand and mud may be scraped away to expose both rather long siphons, about one-third of the body length apart, projecting from the upper surface and long enough to open level with the outer surface of the thick sandy coating. There are strong muscles around both siphons and in short parallel bands around either side of the dorsal and ventral borders of the body. There are only very narrow siphonal vela at the base of both the atrial and branchial siphons. The dorsal lamina is about three-quarters of the length of the branchial sac. There are 6 rows of 8 tall narrow conical infundibula in each row, sometimes subdivided into two apices only at the top of each cone. There are 10 internal longitudinal vessels extending along both sides of the rows of infundibula. The gut loop is long and curved, open at the pole. There are long parallel liver lamellae. The kidney is oval and curved. The gonads are deeply curved and consist of a central ovarian tube fringed on both sides by long and much branched testis follicles spreading out onto the body wall around the ovary. The testis follicles are not always continuous all around the ovary, but may be absent for part of its length on either side. The right gonad extends anteriorly from the anterior end of the kidney and then curves in a deep 'U' before bending dorsally to open near the base of the atrial aperture. The left gonad extends anteriorly from the concavity of the secondary gut loop and then makes a similar curve posteriorly and dorsally. Vasa efferentia run across the mesial surface of the ovary to join the vas deferens which opens before the ovary curves dorsally toward the atrial aperture.

REMARKS: This interstitial species is very similar to *Molgula habaensis* Van Name, 1945 but differs in the orientation of the gonads. It may be distinguished from the other interstitial species in the present collection by the tall narrow infundibula projecting into the folds, by the absence of an extra row of infundibula, by the long test hairs, thick sand coating and protruberant siphons, by narrow siphonal vela and by the long curved ovaries and the long and branched testis follicle spreading over the body wall around the ovary,

SEASONAL VARIATION: The species was present, mostly in Area II, but also in Area III from June until September, but was absent from samples in March and December 1970 and March 1971. The individuals appear to have a short life span of less than 6 months. The gonads appear to be mature at a very early stage and eggs were present in the peribranchial cavity of specimens of 1.5 cm taken in September. There is a rapid increase in the size of the population present in September 1971 and it is probable that this increase is the result of reproduction by the resident population. The species does not apparently persist in the area to initiate the populations in the succeeding year. The species, therefore, behaves in the area as does *Molgula exigua*.

***Molgula sphaera* sp. nov.**

(Figs. 17–20)

HOLOTYPE: $\frac{1}{2}$ mile S. of Southwest Rocks, Moreton B., sand shell and grit, 8.2 m, Sept. 1970, QM G6319.

PARATYPES: $\frac{1}{2}$ mile SE. of Southwest Rocks, Moreton B., mud, 7.2 m, 3 spems., QM G6082, G6318; $\frac{1}{2}$ mile S. of Southwest Rocks, Moreton B., sand shell and grit, 7 m, 1 spem., G6317. 1 mile S. of Southwest Rocks, Moreton B., sandy mud, 2.5–3.5 m, 3 spems., QM G6081, G6083–4.

DESCRIPTION: These small sandy individuals are absolutely spherical. The sessile apertures are close together on the upper surface. There are only sparse but long test hairs and the sandy coating is embedded in the superficial layer of test making it very brittle. The body wall is closely adherent to the test. Very fine circular muscle fibres are present over the whole body outside the longitudinal bands that radiate from the siphons and become diffuse over the ventral part of the body. There is a narrow branchial velum but no atrial velum was detected. The dorsal lamina is very short and the oesophagus opens half way down the branchial sac. There are 7 rows of 6 infundibula on each side of the body with 3 to 4 internal longitudinal vessels extending along both sides of each row of infundibula. In the most ventral row there are 12 infundibula. There is no extra dorsal row of infundibula. Each infundibulum is very wide basally and subdivides many times and irregularly on several places in the summit of the folds. The gut loop is long, deeply curved and open at the pole, and the kidney is fairly long and curved. The gonads consist of an almost circular ovary completely surrounded by long branched testis follicles tightly packed. The vasa efferentia join into 3 to 5 main ducts on the surface of the ovary, which open into a voluminous seminal vesicle that narrows to a vas deferens opening at the base of the short oviduct.

REMARKS: The species is characterised by its thin brittle test, its short dorsal lamina and closely placed apertures, by its conical infundibula and their irregular subdivision apically, by the circular gonads and seminal vesicle and by the long curved kidney.

SEASONAL VARIATION: The species is rare and was taken only in June and September 1970 and in September 1971. Larger individuals were taken in September but there was no great increase in their number. There is no indication therefore that the populations are reproducing.

***Molgula diversa* sp. nov.**

(Fig. 21)

HOLOTYPE: $\frac{1}{2}$ mile S. of Southwest Rocks, Moreton B., sand, shell and grit, 7.7 m, June 1970, QM G6320.

PARATYPES: $\frac{1}{2}$ mile S. of Southwest Rocks, Moreton B., sand, shell and grit, 8.5–10 m, 2 spems., QM G5992, G6321. 1 mile S. of Southwest Rocks, Moreton B., sandy mud, 3.5–6 m, 2 spems., QM G5989, G5991.

DESCRIPTION: Small specimens covered with a thin coating of sand and mud. There are some relatively sparse short test hairs around the posterior surface of the body. The apertures are on very short siphons, close together on the dorsal surface and directed away from one another. There are wide atrial and branchial vela at the base of the siphons. The dorsal lamina is very short and the oesophagus opens about half way down the branchial sac. There are 7 rows of 7 tall conical infundibula that are subdivided for most of their extent so that double that number is present and the primary 7 in each row is evident only at the base of the cone in the interspace between the folds. There are 3 to 5 internal longitudinal vessels along both sides of the rows of infundibula. The gut forms the usual curved loop and the kidney is straight and elliptical. The gonads consist of flask-shaped ovaries with testis follicle only along the postero-ventral side of the ovary. On the right the gonad is dorsal and almost parallel to the kidney but diverging slightly distally toward the atrial aperture. On the left the gonad extends from inside the gut loop postero-dorsally toward the atrial aperture.

REMARKS: The species is characterised by the closely placed and diverging siphons, by the short dorsal lamina and well developed siphonal vela, by the well developed conical infundibula subdivided for the whole of their height so that double the primary number are present in the branchial sac and by the form of the gonads with testis follicles only along one side of the ovary and not spreading out onto the body wall.

SEASONAL VARIATION: The species is rare in the area studied and was taken only during June, September and December 1970 and in September 1971. There is no indication that this population is producing juveniles.

***Eugyra moretonensis* sp. nov.**

(Figs. 23, 24)

HOLOTYPE: $\frac{1}{2}$ mile SE. of Southwest Rocks, Moreton B., mud, 7.2 m, Sept. 1970, QM G6328.

PARATYPES: $\frac{1}{2}$ mile SE. of Southwest Rocks, Moreton B., mud, 5–5.5 m, 6 spems., QM G5965, G5972–3, G6329. $\frac{1}{2}$ mile S. of Southwest Rocks, Moreton B., sand, shell and grit, 7 m, 1 spem., QM G5975. 1 mile S. of Southwest Rocks, Moreton B., sandy mud, 2.5–3.5 m, 21 spems., QM G5961–4, G5966–71, G5974, G5976.

DESCRIPTION: The body is soft and laterally flattened and covered with fine sand and mud which is held in place with long hair-like extensions of the test. The apertures are close together on the upper surface in an area of very soft sand-free test slightly depressed into the upper surface. The atrial siphon when extended is about three times the length of the branchial siphon, which is almost sessile, and is directed away from it. The atrial siphon is,

however, very muscular and contractile, and when withdrawn its soft test falls into gathers around it. There are 7 internal longitudinal vessels in the branchial sac each crossing the centre of a row of 6 infundibula although in the ventral row there are twice that number. There is also an extra row of infundibula dorsally not crossed by a longitudinal vessel. The spirals protrude slightly and are not flat. The gut forms a narrow loop, deeply curved in its proximal part. The anus is smooth rimmed. The kidney is long and curved. The pole of the loop is open. The stomach is short and rectangular with about 10 longitudinal folds. The gonads consist of elongate tubular ovaries opening by a short oviduct directed toward the atrial aperture and with a 'fan' of testis follicles around the proximal end, their ducts joining the vas deferens on the mesial surface of the ovary. The vas deferens is free for most of its length and opens about half way along the length of the ovary. On the right side of the body the gonad is dorsal to and parallel with the kidney; on the left the proximal part of the ovary with its associated testis follicles is accommodated in the loop of the gut, the ovary and vas deferens then crosses over the descending limb of the gut loop and extends dorsally more or less parallel to the rectum. Well-developed tail-less embryos are present in the peribranchial cavity.

REMARKS: This is the first species of this genus described from Australia although in view of its small size this and other species could well have been overlooked. It is characterised by the unusually large number of internal longitudinal vessels, and by the single opening of the vas deferens. The characteristically retractable siphons are identical with those previously described for this genus, although previously the branchial siphon has been regarded as longer than the atrial siphon. The genus is found exclusively on the open sea floor and has been recorded from a wide range of depths and geographical locations from arctic to antarctic seas. However, no great range in morphology between the different species of the genus has been described.

SEASONAL VARIATION: The species is present in June and in increased numbers in September in both 1970 and 1971. Embryos are present in the peribranchial cavity of specimens of 1 cm collected in September, so the populations are reproducing. Their presence in the area is, however, seasonal, and the initial populations established in June have, presumably, been derived from adjacent areas where the species is able to survive those influences which cause their mortality.

STATION INFORMATION

Area I: Mud, $\frac{1}{2}$ mile SE. of Southwest Rocks, Peel Island, 4.5 to 6 metres.

Area II: Shell, grit and sand, $\frac{1}{2}$ mile S. of Southwest Rocks, Peel Island, 6 to 9 metres.

Area III: Sand, mud and shell, 1 mile S. of Southwest Rocks, Peel Island, 2.5 to 4.5 metres.

Of these, Area I has a consistently poor ascidian fauna, possibly correlated with the mud substrate and the interstitial molgulids are especially affected. Area II has the most consistently diverse and the more densely distributed fauna. Each species, however, is not randomly distributed and most occur grouped together.

Table 1 shows the total numbers of species in 5 samples at 5 locations in each of the areas I to III over the period March 1970 to September 1971.

TABLE 1
OCCURRENCE OF SPECIES AT 5 STATIONS IN AREAS I TO III

Species	1970												1971								
	March			June			September			December			March			June			September		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
FIXED SPECIES																					
<i>P. fungiformis</i> ..	1	5	3	—	18	5	—	21	2	—	17	2	1	5	1	2	7	—	—	2	1
<i>P. pedunculata</i> ..	—	3	—	—	—	—	2	1	—	—	2	1	—	2	—	1	1	3	—	2	3
<i>S. stolonifera</i> ..	—	2	1	3	—	—	—	3	3	—	—	2	2	1	—	—	—	—	—	—	4
<i>A. sydneyensis</i> ..	—	—	—	—	—	—	—	1	—	—	2	—	—	—	—	—	—	—	—	1	1
<i>S. plicata</i> ..	—	—	—	—	—	—	—	1	2	—	—	—	—	—	—	—	5	—	—	—	—
<i>M. spinifera</i> ..	—	—	—	—	—	1	—	3	—	—	—	—	—	—	—	1	1	—	—	1	1
<i>M. exasperatus</i> ..	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>M. stolonifera</i> ..	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>M. nichollsi</i> ..	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
<i>M. australis</i> ..	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
<i>B. nigrum</i> ..	—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—
<i>P. vittata</i> ..	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>S. pedunculata</i> ..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	1
FREE-LIVING SPECIES																					
<i>P. tinctor</i> ..	1	1	4	—	11	4	—	11	11	—	14	3	—	—	1	—	3	4	—	2	8
<i>M. sabulosa</i> ..	—	—	1	—	—	—	2	1	1	—	64	35	—	—	—	—	—	—	—	1	25
<i>S. ramificata</i> ..	—	5	2	—	8	1	—	1	—	—	2	—	—	—	—	—	—	—	—	—	1
<i>M. exigua</i> ..	—	—	—	—	15	5	—	22	20	—	1	6	—	—	—	—	2	1	—	5	8
<i>A. aclara</i> ..	—	—	—	—	2	—	—	3	—	—	1	—	—	—	—	—	2	8	—	5	3
<i>C. floccosa</i> ..	—	—	—	—	1	2	—	1	1	—	2	1	—	—	—	1	—	—	—	—	2
<i>M. rima</i> ..	—	—	—	—	6	1	—	1	2	—	—	—	—	—	—	—	13	—	—	8	30
<i>E. moretonensis</i> ..	—	—	—	—	1	2	8	—	1	—	—	—	—	—	—	—	—	1	1	1	21
<i>A. glaciata</i> ..	—	—	—	—	—	—	7	—	6	—	1	—	—	—	—	—	—	—	24	—	324
<i>A. opaca</i> ..	—	—	—	—	—	—	—	3	—	—	1	—	—	—	—	—	6	—	—	6	3
<i>M. diversa</i> ..	—	—	—	—	2	—	—	—	2	—	1	1	—	—	—	—	—	—	—	1	2
<i>M. sphaera</i> ..	—	—	—	—	—	1	1	2	1	—	—	—	—	—	—	—	—	—	2	—	2

CHARACTERISTICS OF THE ASCIDIAN FAUNA

Of the twenty-four species comprising the ascidian fauna of this area, a relatively large number (12) are not fixed but lie free on the sea floor. This number includes 5 new species of the family Molgulidae, possibly endemic to Moreton Bay. There are 5 other species which are not endemic but are, nevertheless, unusual in their distribution, having previously been

recorded only from widely separated geographic locations, usually in regions protected from the open ocean. Thus, in addition to the Moreton Bay records, *Ascidia aclara* has been taken from St Vincent Gulf, Port Phillip Bay, Lakes Entrance; *Adagnesia opaca* has been taken only from Port Hacking; *Styela ramificata* only from the Gulf of Carpentaria; *Cnemidocarpa floccosa* is known only from Indonesia; and *Agnesia glaciata* has a cosmopolitan distribution in sheltered locations in the Pacific and southern oceans. These free living species are most often present in greater numbers than the fixed species, and appear to be more successful in this area.

In regions at the mouth of rivers, freshwater flooding, deposition of silt, and temperature fluctuation may cause annual mortality amongst the benthic fauna. The life history of individuals in those populations that are vulnerable to such seasonal events is therefore limited, and the individuals may not grow very large and must reach sexual maturity early. The branchial sac is equally limited in size and cannot accommodate any great increase in its perforated area by the formation of the deep folds that are characteristic of most other species of stolidobranch ascidians. The branchial sac of small individuals, however, will accommodate an increase in the area perforated by cilia-lined stigmata by the formation of spiral infundibula. Therefore, in those locations where seasonal variations cause mortality, and an annual fauna reaching early maturity is favoured, or where small sized individuals are favoured in the interstitial benthic fauna, species of the families Molgulidae and Agnesiidae appear to fulfil the requirements. The free living species in the area surveyed include a significantly high proportion of species of these families. Where seasonal changes in the environment do not occur to cause annual mortality it is probable that individuals of the same species would continue their growth. In this respect the very large size range recorded for *Ascidia aclara*, *Adagnesia opaca* and *Molgula sabulosa* is significant (from 1 cm up to 6 cm in greatest dimension).

The fixed species taken, with the exception only of the stalked *Polycarpa fungiformis*, are known from a wide range around the Australian coast. They do not appear to have any special adaptation for the sea floor in the region surveyed and have only been taken there occasionally. *Polycarpa fungiformis*, however, is present in large numbers and is otherwise known only from a single specimen in the Papuan Channel (Northeast of Cairns, Great Barrier Reef; Hastings, 1931).

ENLISTMENT

Except for those species that persist in the area throughout the year, a population is initiated when larvae, from an area (probably in deeper water further from the river mouth) which has been less influenced by seasonal fluctuations in salinity and temperature, settle as juveniles. The rate of growth for many of the species is relatively rapid and sexual maturity is often reached at an early stage. The juveniles appear in the populations of many of these species throughout the period when it is present and may therefore be the offspring of maturing adults in the resident population. However, in many cases the number of specimens sampled is small and suggests a very low density of individuals, representing populations which do not increase in size and do not appear to be reproducing. Thus the species of ascidian present in the area may also be subdivided into the following groups according to the behaviour of the populations in the area surveyed:

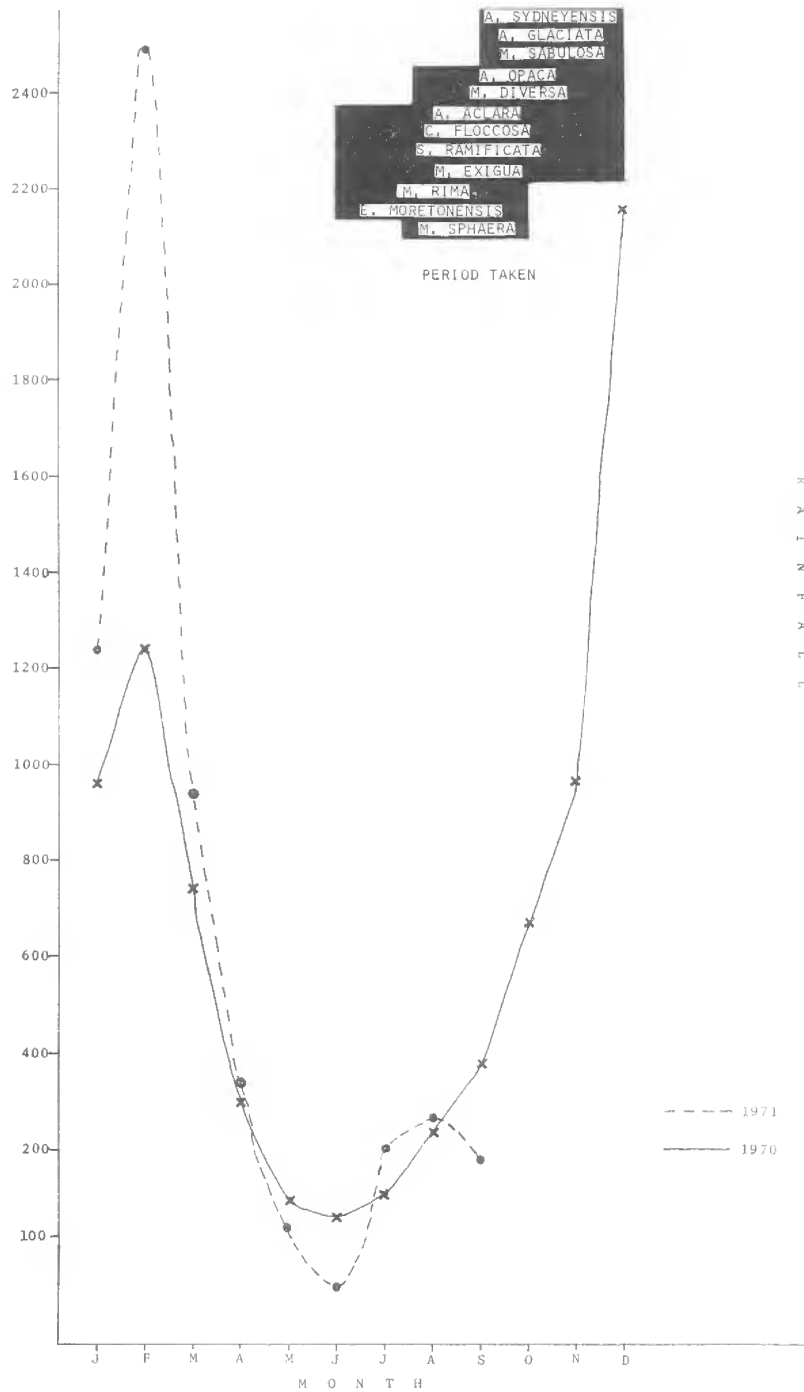


FIG. 25: Average of rainfall recorded at Springbrook and Beaudesert in the Logan and Albert Rivers catchment.

SPECIES ENLISTED FROM OTHER AREAS WHICH DO NOT
SET UP BREEDING POPULATIONS IN THE AREA

These are only rare components of the fauna and absence of sexual reproduction may be due to their sparse distribution preventing effective fertilisation of gonadial products (Kott, 1969). Only *Adagnesia opaca*, *Molgula sphaera* and *M. diversa* are possibly viviparous. The other species involved are most likely to be oviparous, with larvae of fairly long life. Both gonadial products and larvae are thus exposed to wide dispersal which could be the explanation for their sparse distribution. The absence of suitable substrate for these species, which are mostly fixed, may also contribute to their lack of success.

*Ascidia sydneyensis**Adagnesia opaca**Botrylloides nigrum**Styela plicata**Styela stolonifera**Styela ramificata**Polycarpa pedunculata**Pyura vittata**Microcosmus spinifera**Microcosmus exasperatus**Microcosmus australis**Microcosmus stolonifera**Microcosmus nicholli**Molgula sphaera**Molgula diversa*SPECIES ENLISTED FROM OTHER AREAS WHICH DO SET UP
BREEDING POPULATIONS BUT EXPERIENCE AN ANNUAL MORTALITY
PREVENTING THE ESTABLISHMENT OF SELF-PERPETUATING POPULATIONS

These are frequent seasonal components of the ascidian fauna and appear to be adapted for the substrates available. They are often free living and reach maturity early. Only very occasionally do specimens survive from year to year (e.g. *Cnemidocarpa floccosa*). At least *Eugyra moretonensis*, and probably some of the *Molgula spp.* are viviparous, with short lived larvae not subject to wide dispersal. Settlement is thus effected in sufficient density to ensure that sexual reproduction can take place. Some value, however, must be attached to dispersal for species in areas subject to annual mortality from some seasonal factor.

*Ascidia aclara**Agnesia glaciata**Cnemidocarpa floccosa**Molgula sabulosa**Molgula exigua**Molgula rima**Eugyra moretonensis*SPECIES WITH PERSISTENT POPULATIONS PRESENT
THROUGHOUT THE YEAR AND REPRODUCING

Polycarpa tinctor is known to be viviparous and anural; thus avoiding dispersal and ensuring populations of sufficient density for sexual reproduction. The species spawns in June to September.

Polycarpa fungiformis spawns in March to June.

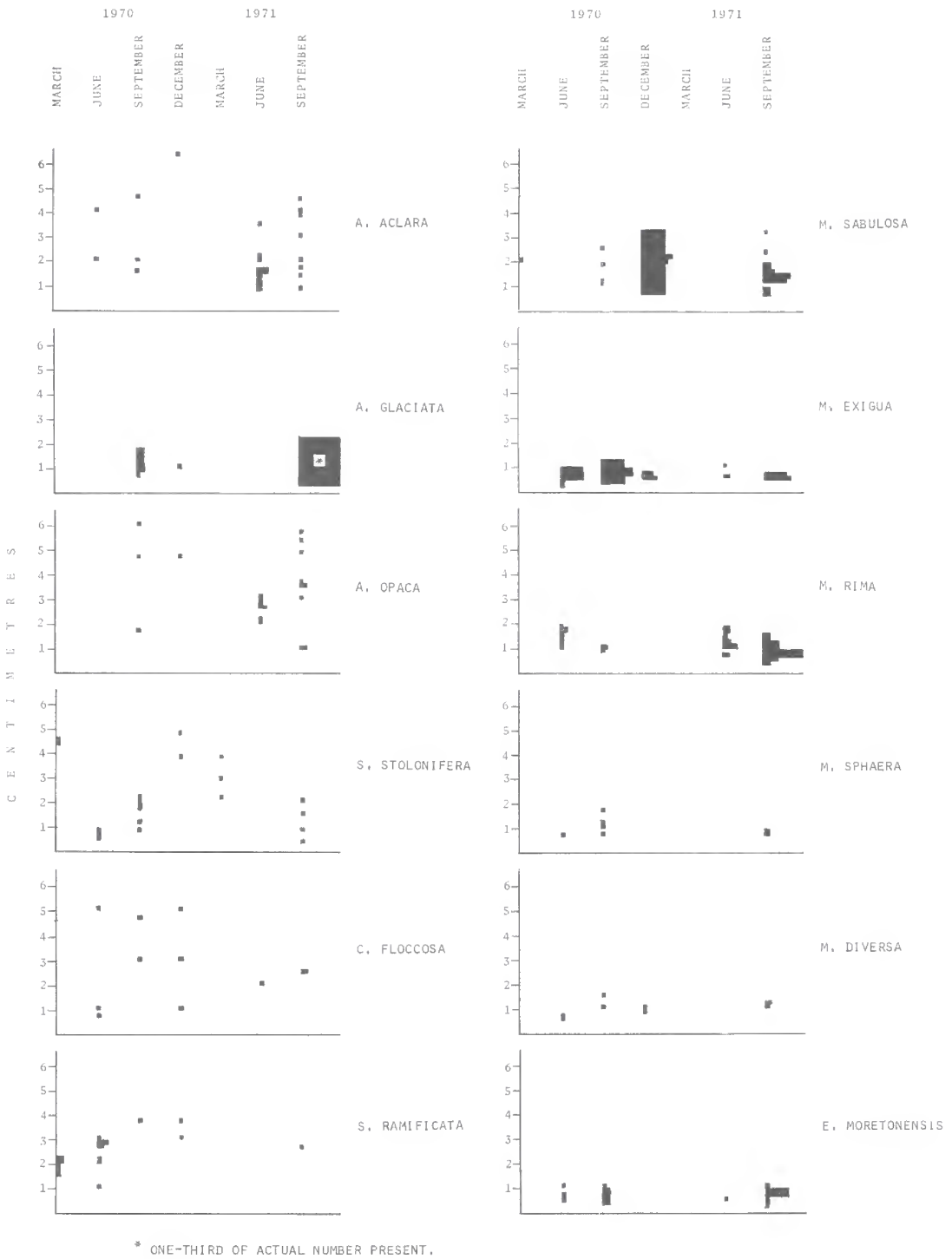


FIG. 26: Size and abundance of certain ascidian species in the survey area.

SEASONAL VARIATIONS

SPECIES PERIODICITY (Figs. 25, 26): In 1970 there was a high rainfall in the Logan and Albert Rivers catchment area in the period Jan.–Feb. After that only low falls were recorded until December 1970 when a normal summer rainfall continuing until March 1971 occurred. There followed a dry winter with little or no rain up to October 1971. Surface temperatures for the Logan River are available for 1952 (Rochford and Spencer, 1953) and in that year they reached their minimum in June and their maximum during December.

The disappearance of most species from the area during December may be associated with either the reduction in salinity that occurs during the period of maximum rainfall or the increase in temperature at that time (Rochford and Spencer, 1953). Most species reappear in the fauna in the period June–September coinciding with the dry winter and the lowest temperatures of the year. Populations build up to reach their maximum in September. The uniform behaviour of populations of the great majority of species tends to confirm the reliability of the sampling methods.

Unfortunately there is not a great variation in the rainfall registered during 1970 and 1971. It is possible that the higher rainfall in February 1971 inhibited settlement of *Styela ramificata*, *S. stolonifera*, *Molgula sabulosa*, *M. exigua*, *M. diversa* and *M. sphaera*. On the other hand, greater numbers of *Agnesia glaciata*, *Molgula exigua* and *M. rima* settled in September 1971 than in 1970 and this may reflect a population increase that was not inhibited by an earlier rainfall such as that registered in 1970. In this respect *Adagnesia opaca* was taken in June 1971 but not in June 1970. There may be, however, other unidentified factors affecting the settlement of each species.

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